Data in Astronomy, the virtual observatory, ...

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CDS

Plan

- Context
  - The CDS
  - Data and data centres in the astronomical community
  - The Virtual Observatory (VO) and its technical challenges
  - VO standards (VOTable, Registry, VOSpace, ...)
- VOSpace and iRODS
- Illustrations
- EuroVO projects (AVO, VOTECH, DCA, AIDA)
- References

The CDS

- Centre de Données astronomiques de Strasbourg (since 1971)
  - Team of astronomers, engineers and librarians
  - Main services
    - VizieR is a catalogue (>7 800) access service, large catalogues can have more than 10^9 entries
    - Simbad provides basic data, cross-identifications, bibliography and measurements for (> 4 700 000) astronomical objects outside the solar system
    - Aladin, a sky altlas with interoperability capabilities
  - Services are widely used by the community (average > 250 000 hits per day)
- Main French partner of the Virtual Observatory project

Astronomical data

- *Observation* : "detection of a signal, carried out by someone at a particular point and a particular time, with a certain instrument for a particular purpose", *Carlos Jaschek, "Data in Astronomy", 1989*
  - signal : radio, image, spectrum, ...
  - someone : NASA, ESO, ESA, universities and institutes, ...
  - particular point : northern/southern hemisphere, ...
  - particular time : epoch (J2000, B1950, ...)
  - instrument : telescopes (optical, radio), satellites, interferometers, etc.
  - purpose : cartography, magnitude, distance from Earth, chemical composition, etc.

Astronomical data (2)

- From raw data to publications
  - The observations
    - Raw data
    - Observation registries
    - Calibrations and auxiliary data
  - Reduced data
    - Catalogues (physical units) (example : VizieR on line service at CDS)
    - Databases
  - Publications
    - Papers
    - Documentation, “grey substance” literature, etc.

Data centres

- Management of data of spatial missions and ground observatories
  - Data are mainly where the expertise is
  - Massive data processing
  - ...
- Cooperation is a “tradition” and is easy
- Small community
- Go further with the concept of Virtual Observatory

To the Virtual Observatory

- Access to the digitised sky, using archived and interconnected observations (especially large surveys of the whole sky, observed at different wavelength)
  - Inventory of the data available at the international scale
    - Coherent set of archives, surveys, services, and reference dictionaries
    - Standardized data access modes, Interoperability
- Scientific challenges
  - Understand the structures of the Universe at a large scale
  - Formation and evolution of our Galaxy (and others...)
  - Rare object discovery (black matter, extrasolar planets…)
- Educative and cultural dimension, outreach

(www.) IVOA (.net)

- *International Virtual Observatory Alliance*, started in 2000
- Consortium of national and transnational Virtual Observatories
- Different Working/Interest groups
  - Semantics, Grid and Web Services, Data Model, Data Access Layer, VO Query Language, Applications, Theory, …
- 2 meetings / year, active mailing lists, …
- Standardisation work
  - Notes, Working drafts, Proposed recommendations, …
  - ~like W3C

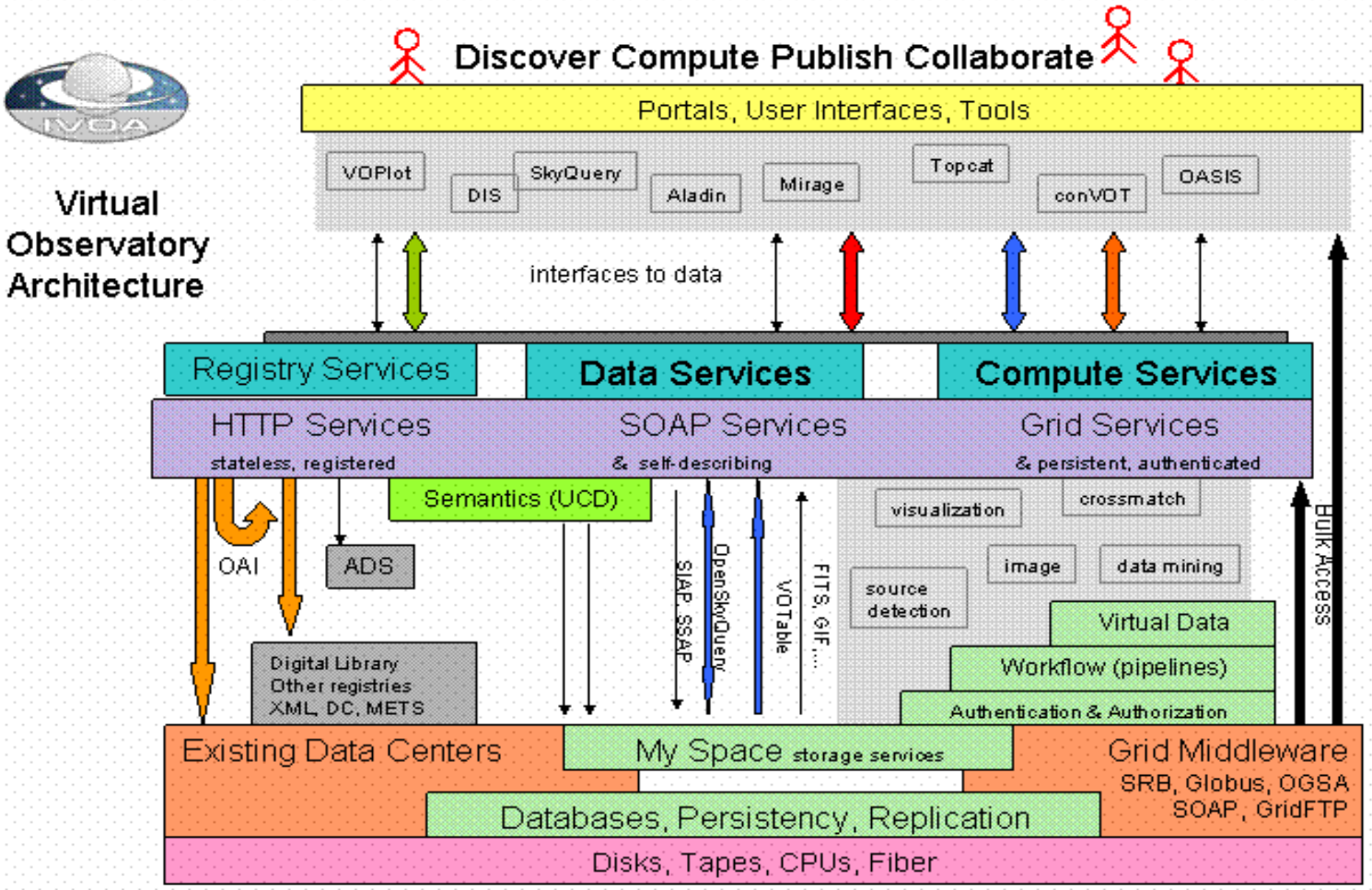
IVOA (2)


RVO
Astro Grid
Aus-VO
VObs.it
China-VO
vo-i
CVO
BRAVO
NVO
NATIONAL VIRTUAL OBSERVATORY
IVOA
SVO
Spanish Virtual Observatory
ArVO
Armenian Virtual Observatory
EURO VO
JVO
HVO
Hungarian Virtual Observatory
GERMAN ASTROPHYSICAL
GAVO
VIRTUAL OBSERVATORY
France

VO technical challenge

- Long time storage of petabytes of data
  - Mostly archives
  - High availability (used in interactive services, cross-matching between data, etc.)
  - Easy to find
  - ...
- Interoperability between astronomical services
- Computation power
  - Needed for simulations, ...
  - Local clusters not sufficient, use of grids like EGEE

VO Architecture



Some IVOA results

- VO Registry
  - Interfaces to publish, query, and harvest
  - Allows people to publish to a registry by filling a Web form in a Web portal
  - Not unique and centralized, each registry harvests each other to know the new dataset and services added to other VO-registries
  - Compliant with digital library standards (Open Archive Initiative) for metadata harvesting and metadata schema
  - Contains VO resources identfied by a universal identifier, starting with ivo://
- In the future, a VO registry may also accept queries in different languages

Some IVOA results (2)

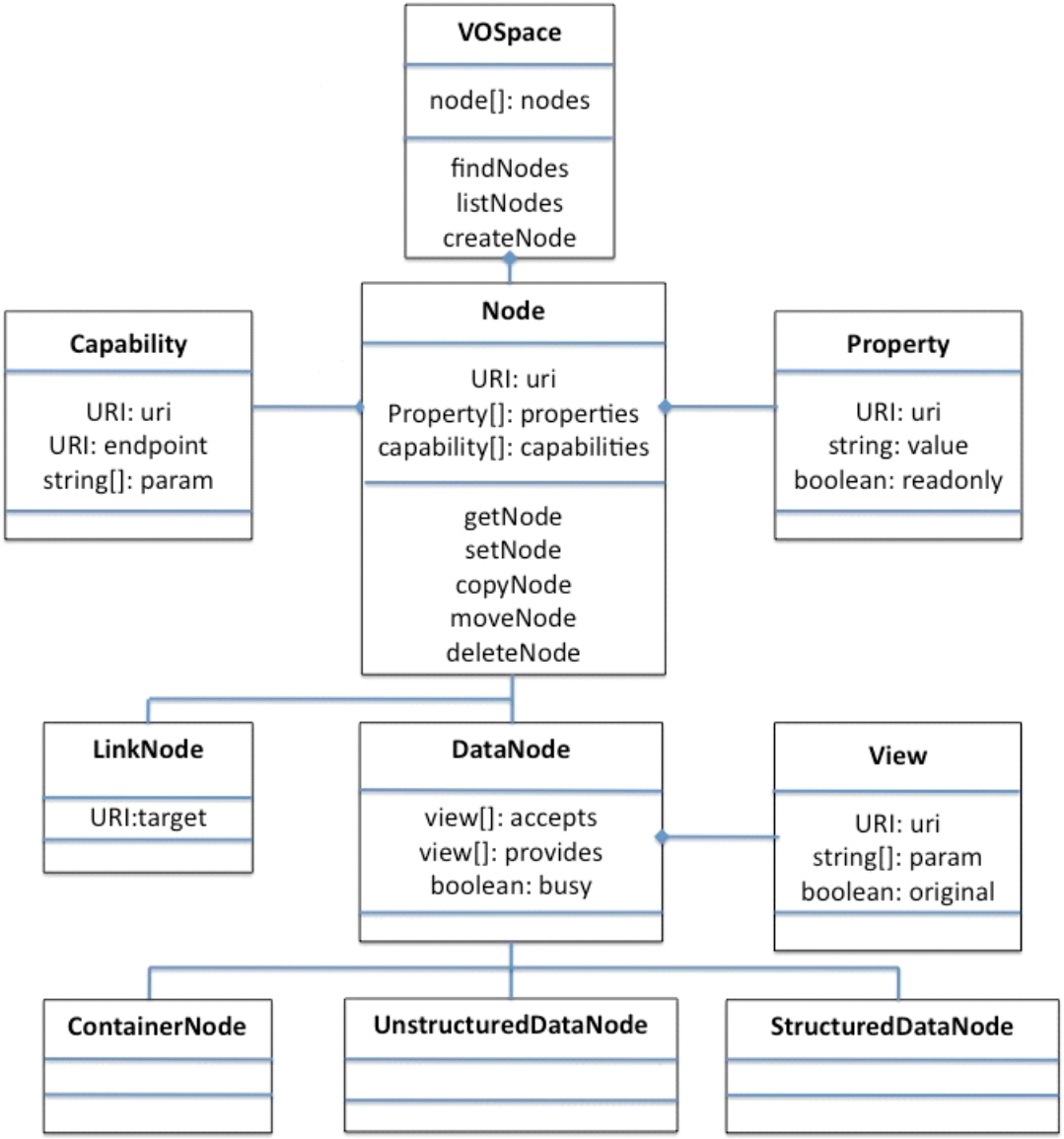
- The UCDs (Unified Content Descriptors)
  - A standardized vocabulary used to describe astronomical quantities and related concepts (in VizieR 1500 UCDs are enough for 100000 columns)
    - "phot.mag;em.IR.K" means a photometric magnitude in infra red between 2 and 3 microns
  - No formal representation structure, with syntax and semantics, describing the relationships and dependencies between the words, and it is not possible to perform automated reasoning on UCDs
- Definition of ontologies...

...	
src.ellipticity	|Source ellipticity
src.impactParam	|Impact parameter
src.morph	|Morphology structure
src.morph.param	|Morphological parameter
src.orbital	|Orbital parameters
src.orbital.eccentricity	|Orbit eccentricity
src.orbital.inclination	|Orbit inclination
...	

Some IVOA results (3)

- VOSpace is the IVOA interface to distributed storage. It specifies how VO agents and applications can use network attached data stores to persist and exchange data in a standard way. A VOSpace web service is an access point for a distributed storage network. Through this access point, a client can:
  - add or delete data objects
  - manipulate metadata for the data objects
  - obtain URIs through which the content of the data objects can be accessed
- *VOSpace does not define how the data is stored or transferred, only the control messages to gain access.* Thus, the VOSpace interface can readily be added to an existing storage system.

VOSpace schema



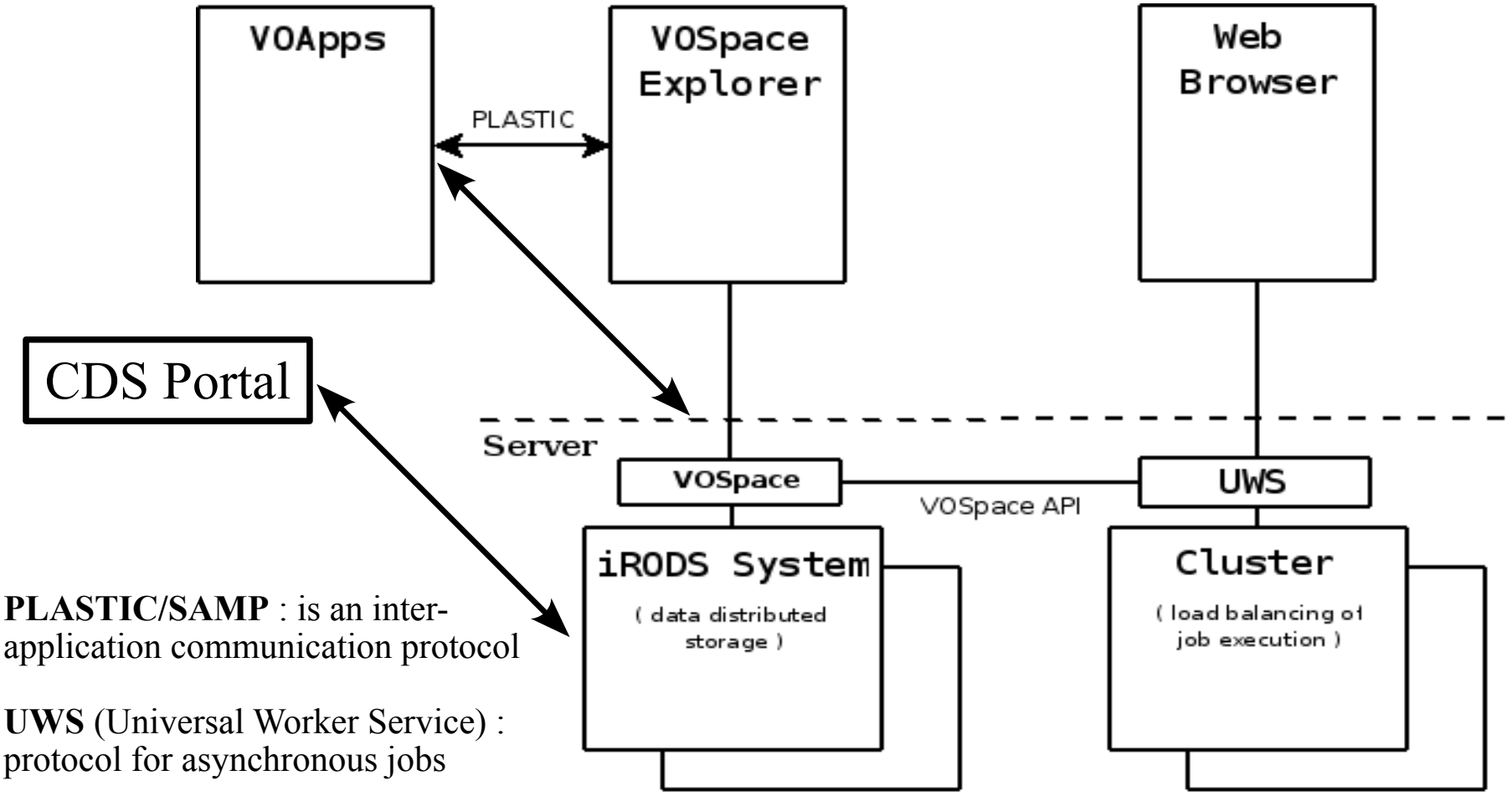
VOSpace and iRODS

- First step : experiment iRODS
  - Development of an Aladin (a sky atlas which is also a VO portal) plugin giving an access to the iRODS implementation through Jargon
- Second step
  - Implemention of the VOSpace interface over iRODS
  - Use of iRODS in the new CDS portal
- Third step : creation of VOSpace client tools
  - A VOSpace Explorer
  - A VOSpace file chooser
- Last step : release for real life (VOSpace and CDS portal)

VOSpace and iRODS (2)

- Use of different iRODS versions
  - iRODS 1.0 for the first prototype, iRODS 1.1 for the second and iRODS 2.0.1 for the final release
  - Jargon API from 1.* to 2.*
- VOSpace
  - Web Service : Axis2 & Tomcat
- iRODS at CDS : 2 quad core servers with 12 TB for the production release → small configuration to evaluate the production needs (not easy to fix “à priori”)
- Implementation of DAVIS
  - Easy to access the data from everywhere

VOSpace-iRODS architecture



PLASTIC/SAMP : is an inter-application communication protocol

UWS (Universal Worker Service) : protocol for asynchronous jobs

VOApps : Aladin, Topcat, VizIvo, VOSpec, etc.

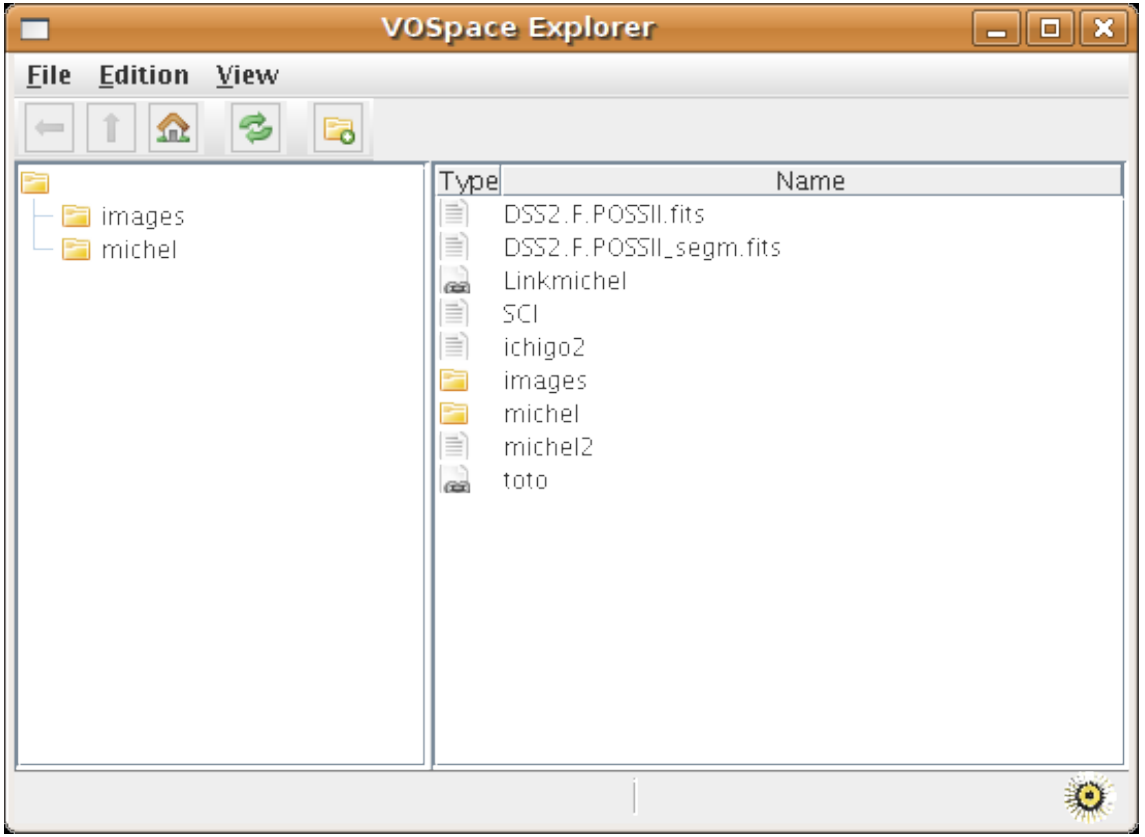
Illustration

VOSpace tools

iRODS provides a robust storage system
in back of VOSpace

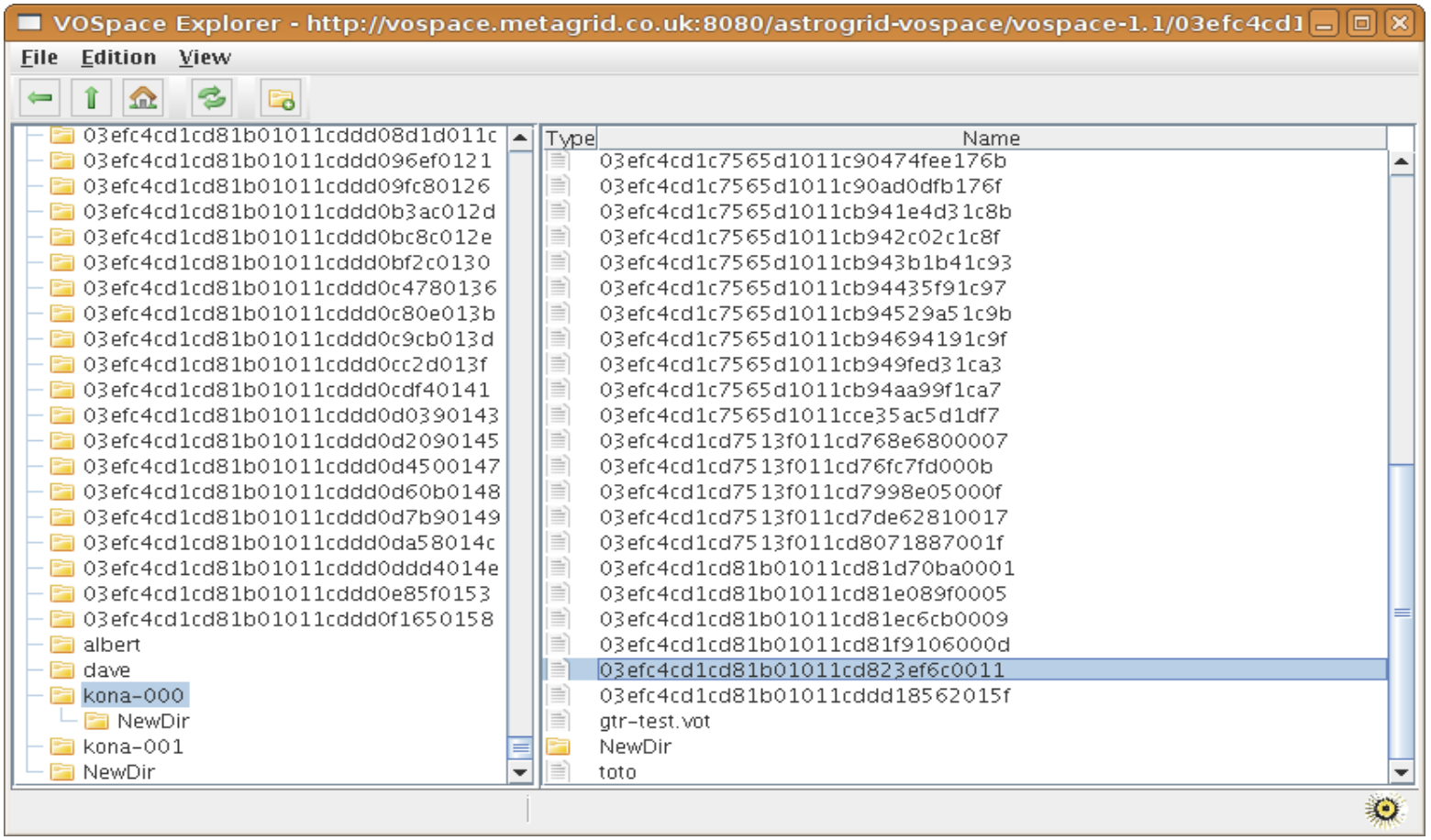
VOSpace Explorer

- Development of a VOSpace Explorer in Java
- If a VO tool supports drag and drop it is possible to interact through this way with the explorer
- PLASTIC/SAMP has been added



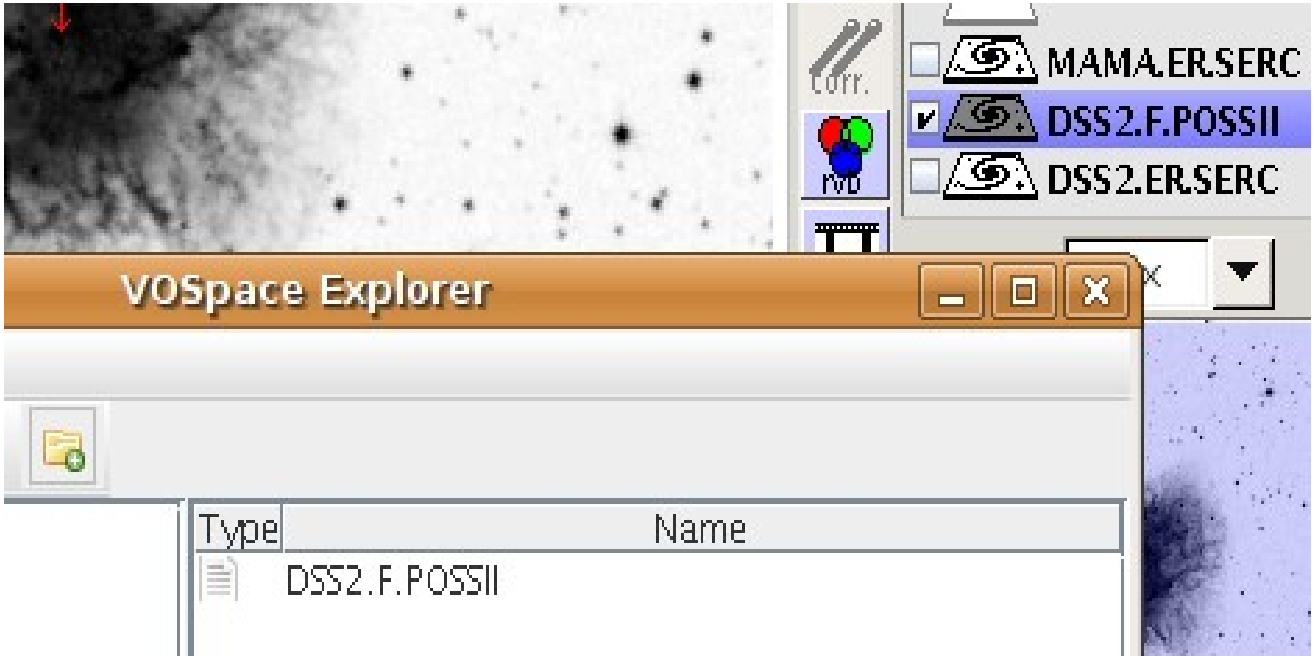
VOSpace Explorer (2)

- Access to other VOSpace, (ex. : Astrogrid's VOSpace, Dave Morris)

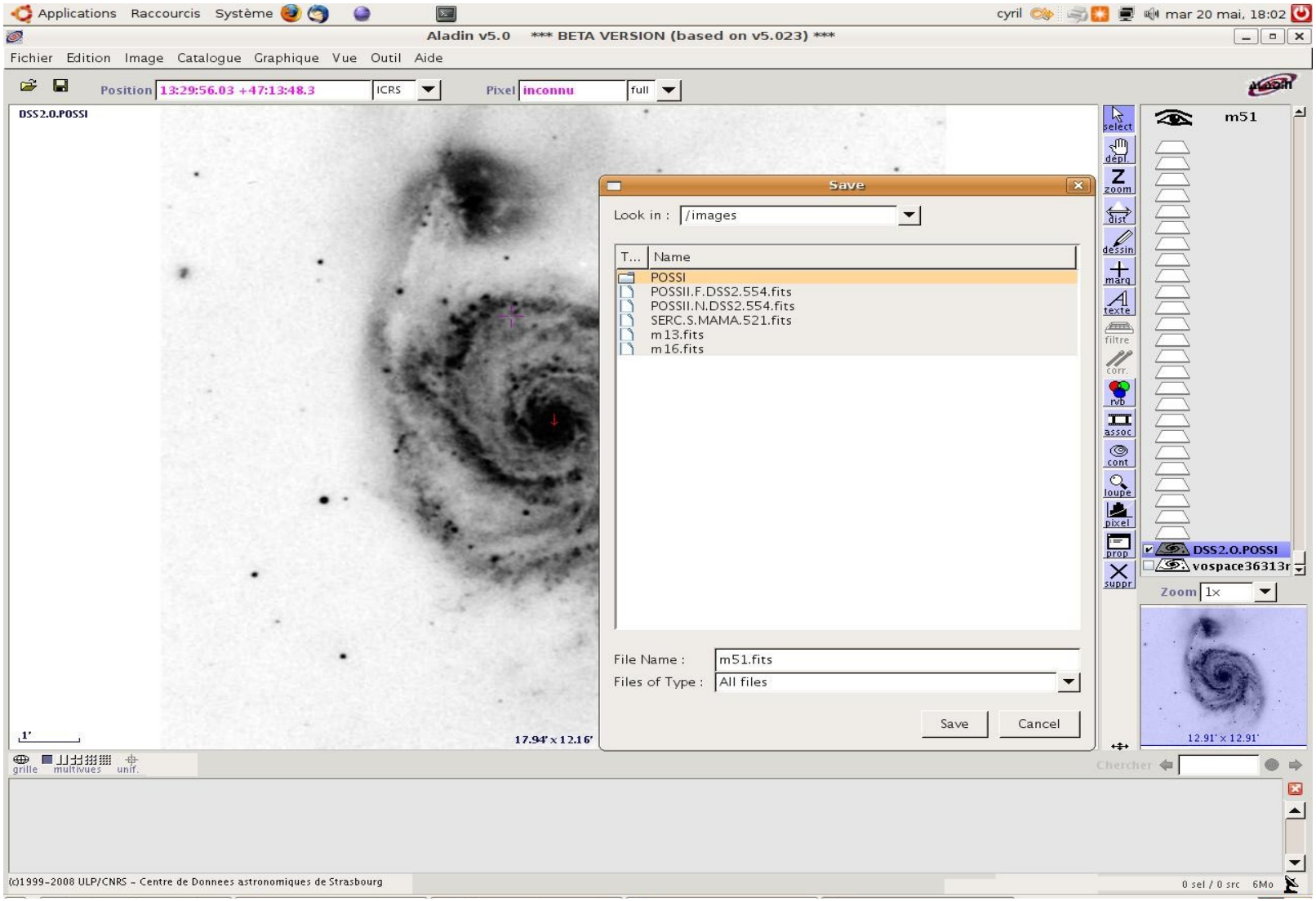


VOSpace Explorer (3)

- PLASTIC/SAMP use between Aladin and the VOSpace Explorer

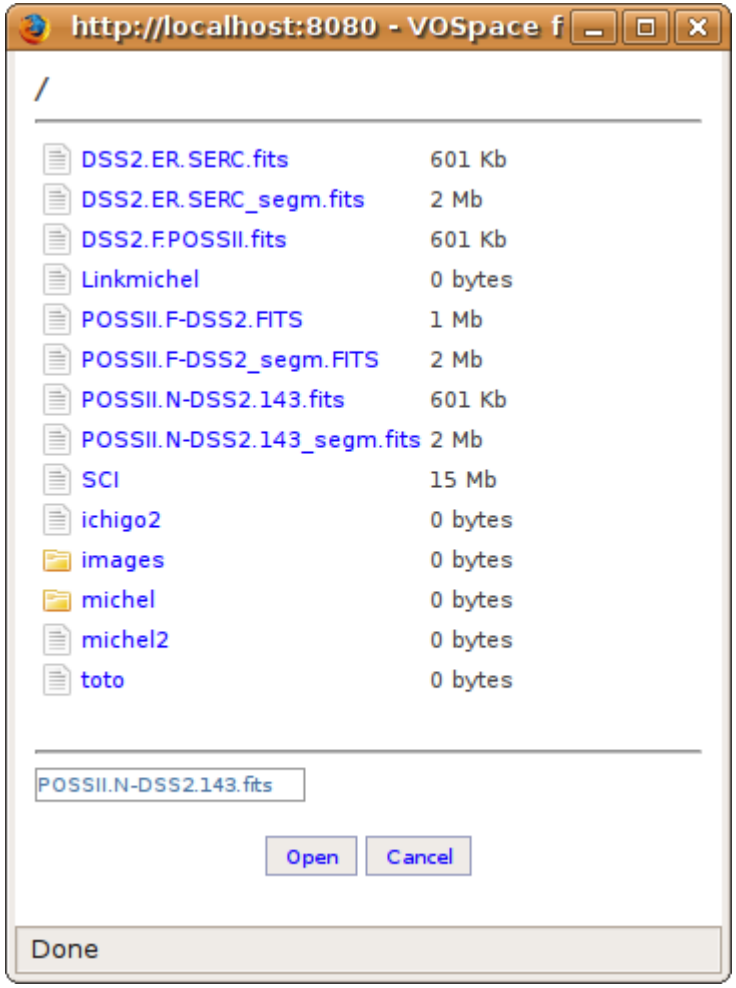


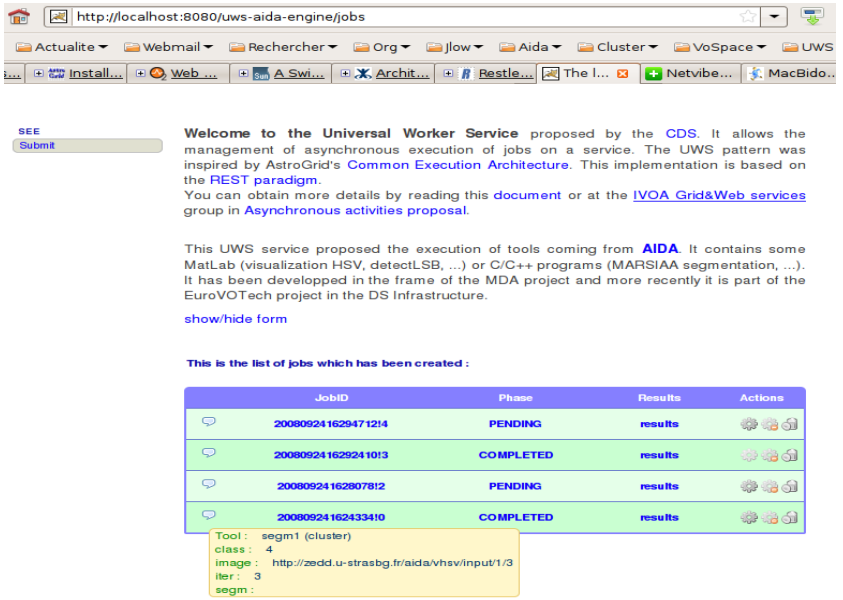
File chooser used in Aladin



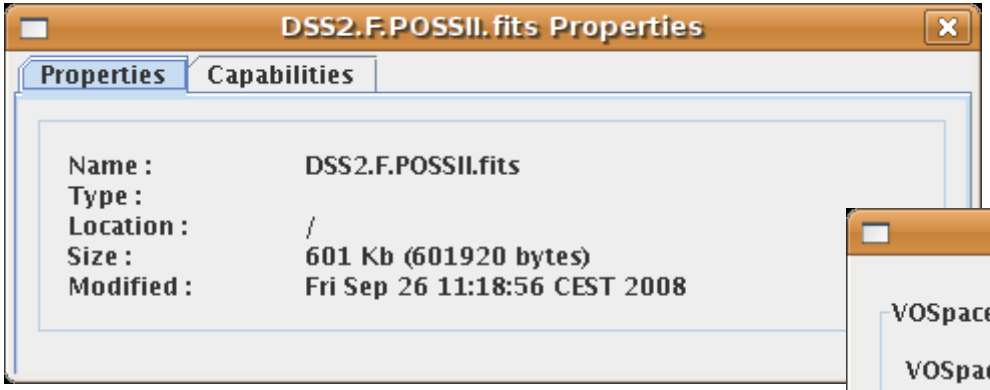
FileChooser as a servlet

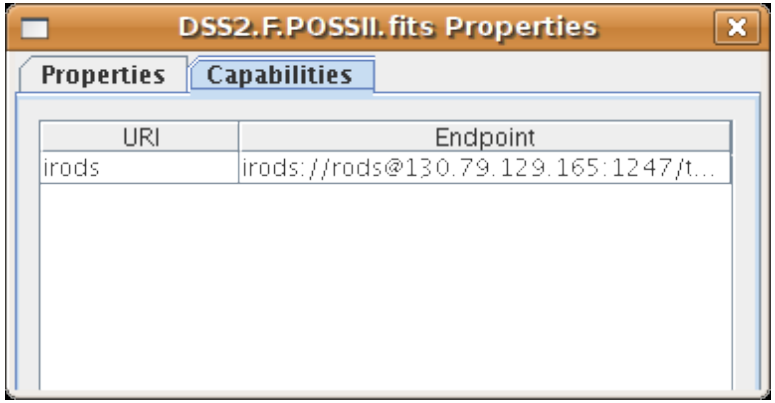
- Used in CDS UWS (Universal Worker Service) framework





Properties, capabilities, security





TLS : with password ok, with certificate soon

Illustration (2)

CDS Portal

iRODS is used to store the user data generated during a session

Developed by Pascal Wassong during the EuroVO AIDA project (ending in June 2010)

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http://cdsportal.u-strasbg.fr/portal.html#m27

Google

Simbad VizieR Aladin Catalogs Dictionary Biblio Tutorials Developers

CDS Portal

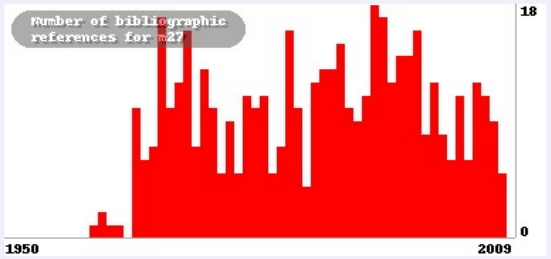
Portal My data Login Register Preferences

Target: m27 GO

J2000 position for m27: 19 59 36.340 +22 43 16.09

Object identifiers, measurements and bibliography for m27

- Object type: Planetary Nebula
- Spectral type: DA
- More SIMBAD data for m27
- 475 bibliographic references
- 14 objects within 2'
- Display map around m27



Images for m27

- Display region in Aladin (Web Start)

Aladin images

Survey	Band	Wavelength (µm)	Size	Epoch	Resolution	Download
2MASS	K	2.16	8.5' x 17.0'	1999-11-04	0.9" / pixel	FITS
2MASS	H	1.65	8.5' x 17.0'	1999-11-04	0.9" / pixel	FITS
2MASS	J	1.24	8.5' x 17.0'	1999-11-04	0.9" / pixel	FITS
POSSII	F	0.65	12.9' x 12.9'	1992-09-19	1.0" / pixel	FITS JPEG
POSSII	F	0.65	12.9' x 12.9'	1996-07-11	1.0" / pixel	FITS JPEG
POSSII	J	0.49	12.9' x 12.9'	1990-07-24	1.0" / pixel	FITS JPEG
POSSII	N	0.83	12.9' x 12.9'	1992-07-22	1.0" / pixel	FITS JPEG
POSSII	N	0.83	12.9' x 12.9'	1995-07-19	1.0" / pixel	FITS JPEG
POSSII	N	0.83	12.9' x 12.9'	1994-06-15	1.0" / pixel	FITS JPEG
POSSI	O	0.64	12.9' x 12.9'	1951-07-13	1.0" / pixel	FITS JPEG
POSSII	J	0.49	13.0' x 13.0'	1990-07-26	1.0" / pixel	FITS JPEG
POSSII	J	0.49	13.0' x 13.0'	1988-06-14	1.0" / pixel	FITS JPEG
POSSI	E	0.40	14.1' x 14.1'	1951-07-13	1.6" / pixel	FITS JPEG

Display grayscale image

Catalogues for m27

- 0 catalogues with 'm27' keyword

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http://cdsportal.u-strasbg.fr/portal.html#m27

POSSII	N	0.83	12.9' x 12.9'	1992-07-22	1.0" / pixel FITS JPEG
POSSII	N	0.83	12.9' x 12.9'	1995-07-19	1.0" / pixel FITS JPEG
POSSII	N	0.83	12.9' x 12.9'	1994-06-15	1.0" / pixel FITS JPEG
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POSSII	J	0.49	13.0' x 13.0'	1988-06-14	1.0" / pixel FITS JPEG
POSSI	E	0.40	14.1' x 14.1'	1951-07-13	1.6" / pixel FITS JPEG

Display grayscale image

Catalogues for m27

- 0 catalogues with 'm27' keyword
- 73 catalogues around m27

Vizier catalogues

	Name	Description	Local density	Wavelength	Popularity	Coverage map
☆	I/297 Query	NOMAD Catalog (Zacharias+ 2005) [ReadMe]	53	optical,IR	85	
★	I/284 Query	The USNO-B1.0 Catalog (Monet+ 2003) [ReadMe]	51	optical	92	
☆	I/305 Query	The Guide Star Catalog, Version 2.3.2 (GSC2.3) (STScI, 2006) [ReadMe]	49	optical	85	
☆	I/304 Query	Carlsberg Meridian Catalog 14 (CMC14) (CMC, 2006) [ReadMe]	36	optical	78	
☆	II/246 Query	2MASS All-Sky Catalog of Point Sources (Cutri+ 2003) [ReadMe]	34	IR	100	
☆	I/267 Query	The APM-North Catalogue (McMahon+, 2000) [ReadMe]	20	optical	79	
☆	J/A+A/469/1221 Query	Sydney observatory Galactic survey (SOGS) (Fresneau+, 2007) [ReadMe]	16	optical	69	
★	IX/10A Query	ROSAT All-Sky Bright Source Catalogue (1RXS) (Voges+ 1999) [ReadMe]	11	X-ray	89	
☆	VI/110 Query	Final Merged Log of IUE Observations (NASA-ESA, 2000) [ReadMe]	10	UV	70	
☆	B/hst Query	HST Archived Exposures Catalog (STScI, 2007) [ReadMe]	10	optical	76	

Page 1 of 8 Displaying 1 - 10 of 73

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Aucun élément dans la corbeille

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http://newviz.u-strasbg.fr/viz-bin/VizieR-3?-source=I%2F284&-c=m27&-c.r=2&-c.u=arcmin

Simbad | VizieR | Aladin | Catalogs | Dictionary | Biblio | Tutorials | Developers

VizieR Search Page

Tokyo, Japan · IUCAA, India · CADC, Canada · Cambridge, UK · CFA/Harvard, USA · UKIRT-Hawaii, USA · INASAN, Russia · Beijing Obs., China

I/284 The USNO-B1.0 Catalog (Monet+ 2003) — Similar Catalogues | ReadMe

1.I/284/out The Whole-Sky USNO-B1.0 Catalog of 1,045,913,669 sources *(1045913669 rows)*

*The **USNO-B Catalog** presents positions, proper motions, magnitudes un blue, red and infrared, as well as star/galaxy estimators for 1,045,913,669 objects derived from 3,648,832,040 separate observations. The data were taken from scans of 7,435 Schmidt plates taken from various sky surveys during the last 50 years. USNO-B1.0 catalog was created by Dave Monet and collaborators at http://www.nofs.navy.mil/data/fchpix/ Note that the star/galaxy estimators may be mixed up in dense regions.*

Query Setup *(usage)*

Maximum Entries per table: 50 | Output layout: CDS portal | Output Order: + - | Reset All

Query by Position on the Sky *(Adapt Form to use a List of targets)*

Target Name (resolved by Simbad) or **Position**: Clear | m27 | J2000 | Target dimension: 2 arcmin | Submit Query

Position in Sexagesimal, or Decimal ° | Radius or Box size

Output preferences for Position:

	r	x,y	Position	Galactic	J2000	B1950
Compute	☑	☐	☑	☐	☐	☐
Sort by	◉	○	○	○	○	○

r and **x,y** are the distance to the Target; **Position** is in the same coordinate system as **Target**.

Query by Constraints applied on Columns

Show	*Sort*	*Column*	Clear *Constraint*		*Explain* *(UCD)*
☑	○	USNO-B1.0		(char)	Designation of the object *(Note 1)* (meta.id;meta.main) (ID_MAIN)
☐	○	Tycho-2		(char)	Designation in the Tycho-2 Catalog I/259 (meta.id) (ID_ALTERNATIVE)
☑	○	RAJ2000		deg	Right Ascension at Eq=J2000, Ep=J2000 *(Note 2)* (pos.eq.ra;meta.main) (POS_EQ_RA_MAIN)
☑	○	DEJ2000		deg	Declination at Eq=J2000, Ep=J2000 *(Note 2)* (pos.eq.dec;meta.main) (POS_EQ_DEC_MAIN)
☑	○	e_RAJ2000		mas	Mean error on RAdeg*cos(DEdeg) at Epoch (stat.error;pos.eq.ra) (ERROR)
☑	○	e_DEJ2000		mas	Mean error on DEdeg at Epoch (stat.error;pos.eq.dec) (ERROR)
☑	○	Epoch		yr	Mean epoch of observation *(Note 2)* (time.epoch;obs) (TIME_EPOCH)
☑	○	pmRA		mas/yr	Proper motion in RA (relative to YS4.0) (pos.pm;pos.eq.ra) (POS_EQ_PMRA)
☑	○	pmDE		mas/yr	Proper motion in DE (relative to YS4.0) (pos.pm;pos.eq.dec) (POS_EQ_PMDEC)
☐		muPr		0.1	(n) Total Proper Motion probability *(Note 7)* (stat.probability) (STAT_PROBABILITY)
☐	○	e_pmRA		mas/yr	Mean error on pmRA (stat.error;pos.pm;pos.eq.ra) (ERROR)
☐	Reset All		Clear		(n) indicates a possible blank or NULL column. Submit Query

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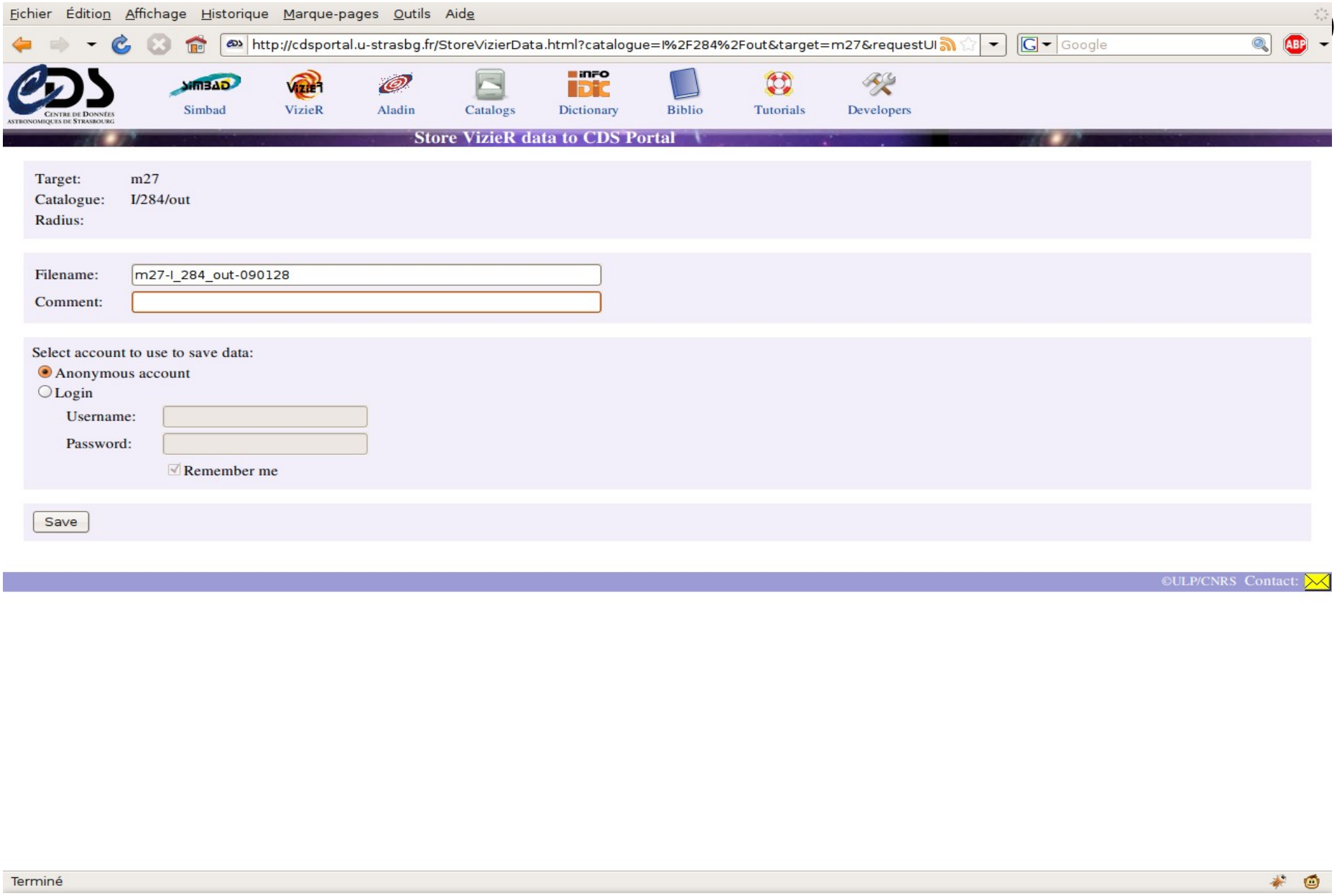
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Google
Centre de Données astronomiques de Strasbourg
Simbad
VizieR
Aladin
Catalogs
Dictionary
Biblio
Tutorials
Developers
Store VizieR data to CDS Portal
Target: m27
Catalogue: I/284/out
Radius:
Filename: m27-I_284_out-090128
Comment:
Select account to use to save data:
Anonymous account
Login
Username:
Password:
Remember me
Save
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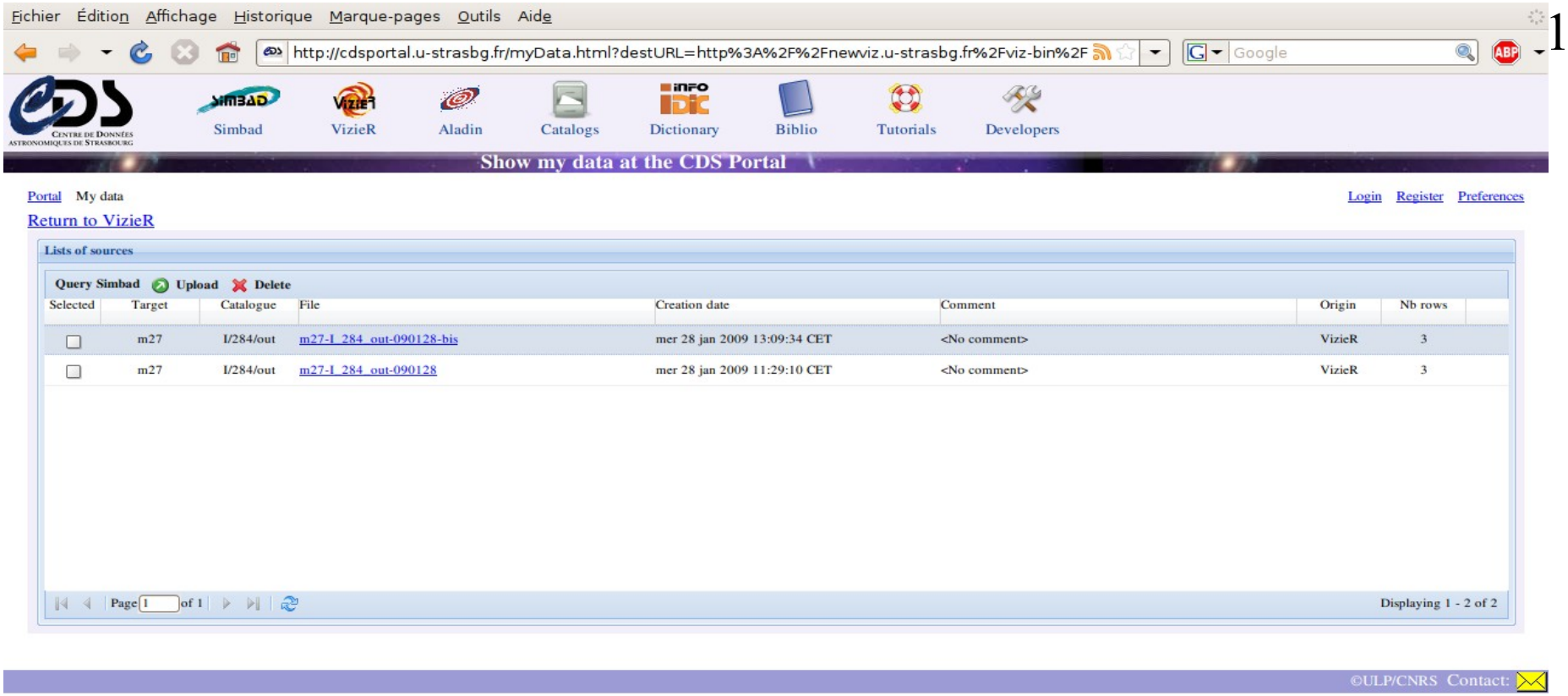
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Portal My data
Login Register Preferences
Return to VizieR
Lists of sources
Query Simbad Upload Delete
Selected Target Catalogue File Creation date Comment Origin Nb rows
m27 I/284/out m27-I_284_out-090128-bis mer 28 jan 2009 13:09:34 CET <No comment> VizieR 3
m27 I/284/out m27-I_284_out-090128 mer 28 jan 2009 11:29:10 CET <No comment> VizieR 3
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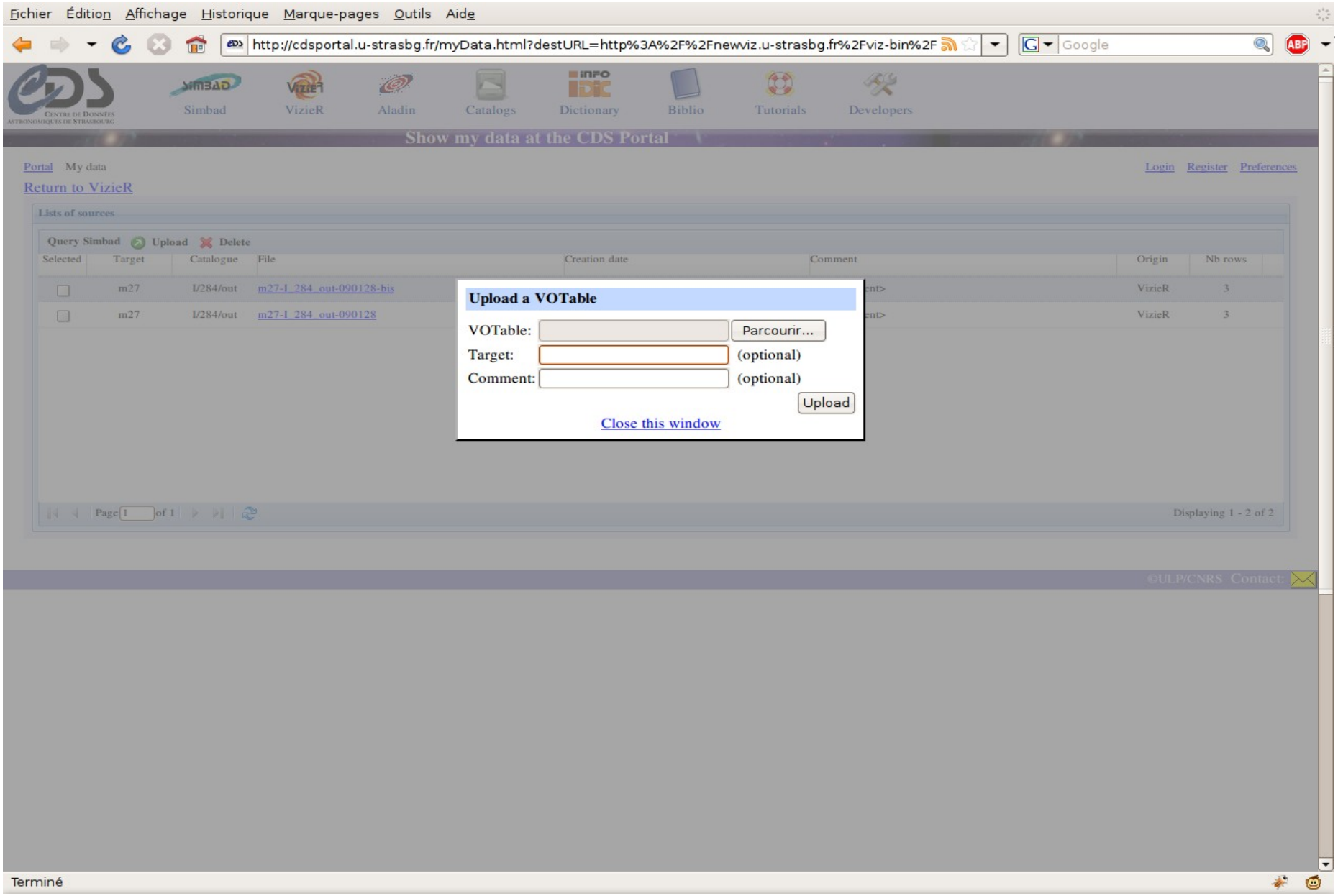
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Lists of sources
Query Simbad Upload Delete
Selected Target Catalogue File Creation date Comment Origin Nb rows
m27 I/284/out m27-I_284_out-090128-bis VizieR 3
m27 I/284/out m27-I_284_out-090128 VizieR 3
Upload a VOTable
VOTable: Parcourir...
Target: (optional)
Comment: (optional)
Upload
Close this window
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European projects AVO, DCA, VOTECH, AIDA

Astrophysical Virtual Observatory (ended)

AVO was the introduction project of the Virtual Observatory in Europe.

It provided the first VO prototype based on Aladin

Partners

- ESO, European Southern Observatory
- ST-ECF, Space Telescope - European Coordinating Facility
- UEDIN, The ASTROGRID (UK) Consortium, UK
- CDS, Centre de Donnees Astronomiques de Strasbourg, France
- CNRSDR01-Terapix, France
- UMAN-Jodrell Bank, The Victoria University of Manchester

Data Centre Alliance (ended)

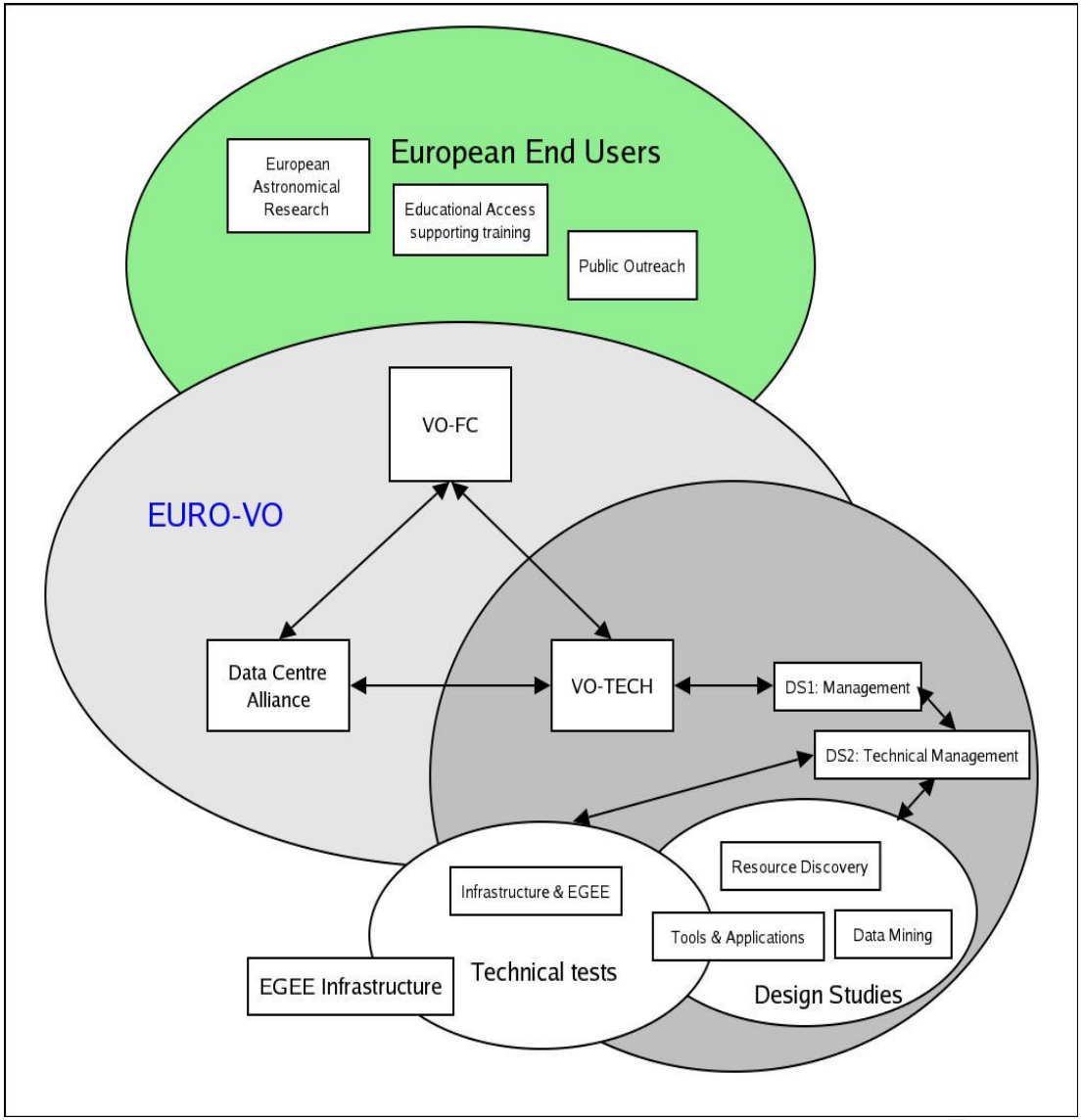
The top level objective of the EuroVO-DCA was to coordinate European Data Centres in forming a co-operating community enhancing the European astronomical eInfrastructure and, thereby, maximising the scientific utilisation of the rich astronomical on-line resources distributed all over Europe.

The objectives of EuroVO-DCA can then be summarized in 6 key points, corresponding to the project work packages

- co-ordinate the national and European Agencies VO initiatives, to implement networking of European data centres (WP2)
- disseminate knowledge and good practice about the VO technical framework (WP3)
- organise feedback from implementation of interoperability standards (WP3-2)
- prepare the inclusion of theoretical astronomy in the VO framework (WP4)
- seek coordination with national and international projects for computational Grids(WP5)
- and help data centres from beyond the partner countries to participate in the VO endeavour (WP6)

VOTECH

(from wiki) The VO-TECH project aims specifically at feasibility studies and design work aimed at integrating new technologies into the EuroVO. Key IT advances to build on are in intelligent resource discovery (ontology and the semantic web), data mining, and visualisation capabilities. These will be integrated via global astronomical interoperability standards coupled with the latest distributed grid computing services. Additionally this project covers design and preparatory work to ensure that data from the major european telescopes and facilities (as represented by the Opticon and RadioNet networks) is fully accessible through the EuroVO, and where required, is able to offload mass scale computational process onto the EGEE backbone.



Astronomical Infrastructure for Data Access

EuroVO-AIDA aims at unifying the digital data collections of European astronomy, integrating their access mechanisms with evolving e-technologies, and enhancing the science extracted from these datasets. The EuroVO-AIDA project is proposed to lead the transition of Euro-VO into an operational phase.

Consortium members *(Agencies and national projects)*

- CNRS, France (CDS, FranceVO)
- European Space Agency
- European Southern Observatory
- INAF, Italy (Trieste, VObs.it)
- INTA, Spain (LAEFF)
- U.Groningen, TheNetherlands (NOVA)
- The University of Edinburgh, UK (AstroGrid)
- U.Heidelberg, Germany (ARI, GAVO)

EuroVO AIDA objectives

- The Virtual Observatory's goal is to provide astronomers with seamless access to data, information, services and tools – a world-wide endeavour
- EuroVO-AIDA will ensure the transition of the European astronomical Virtual Observatory to operations
  - Large scale deployment by data centres
  - Construction of a community of science users
  - Joint Research Activities: definition/evolution of interoperability standards, relevance of new technologies
  - Link with other communities
  - Outreach towards higher education and public

References

- On iRODS Wiki : http://www.irods.org/index.php/VOSpace
- On DICE pages :
  http://www.diceresearch.org/DICE_Site/Uses/Entries/2008/11/5_iRODS_Opens_Virtual_Vistas_for_Astronomy.html
- On IN2P3 Wiki : http://indico.in2p3.fr/conferenceOtherViews.py?view=standard&confId=1234
- IVOA wiki : http://www.ivoa.net
- CDS website : http://cds.u-strasbg.fr
- EuroVO Portal : http://www.euro-vo.org/pub/

Questions ?